

HEMISPHERIC LATERALIZATION IN SARCASM PROCESSING:

THE ROLE OF CONTEXT AND PROSODY

A THESIS SUBMITTED TO THE GRADUATE SCHOOL IN PARTIAL

FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

MASTER OF ARTS IN CLINICAL PSYCHOLOGY

BY

MATTHEW MARGGRAF

DR. THOMAS HOLTGRAVES

BALL STATE UNIVERSITY

MUNCIE, INDIANA

JULY 2010

Running Head: PROSODY AND CONTEXT IN SARCASM

Hemispheric lateralization in sarcasm processing: The role of context and prosody

Matt Marggraf

Ball State University

Hemispheric lateralization in sarcasm processing: The role of context and prosody

Traditionally, it was believed that the left hemisphere (LH) was specialized for the production and comprehension of language processes, whereas the right hemisphere (RH) was strictly designated for non-verbal functions, such as emotional and prosodic processing. However, after consistent research findings, it is apparent that RH is specialized for certain language functions as well (Beeman & Chiarello, 1998). In a literature review on the findings of right hemisphere operations in social psychology, Martin and Shriram (2009) review studies implicating that RH activation is central to a variety of socially relevant processes that relate to language such as empathy, conversational inference, attachment, socialization, the detection of deception, and the activation of alternative meanings. Research on right hemisphere brain damaged patients has also indicated RH involvement in higher level language processing (Wapner, Hamby & Gardner, 1981).

A considerable amount of research has focused on the comprehension of non-literal language, such as indirect requests and irony. From research on both brain-damaged patients and non-impaired participants, it appears that there is RH specialization for processing specific types of irony, such as metaphor and sarcasm. Though numerous studies have demonstrated RH involvement for processing sarcasm (Tomkins & Mateer, 1985; Kaplan, Brownell, Jacobs & Gardner, 1990; McDonald & Pearce, 1996; Winner, Brownell, Happe, Blum & Pincus, 1998; Giora, Zaidel, Soroker, Balor & Kasher, 2000; Channon, Pellieff, & Rule, 2005; Shamay-Tsoory, Tomer & Aharon-Peretz, 2005; Voyer, Bowes & Techentin, 2008), no consensus has been reached in explaining this finding. Some have attributed their findings to RH specialization for processing emotion, attitude and prosody; whereas others have suggested that role of the right hemisphere in

higher level language (discourse, inference making) processing accounts for the lateralization in sarcasm processing. The purpose of the current study is to clarify the contribution of contextual (semantic/discourse) factors and prosodic factors in understanding the hemispheric asymmetry in sarcasm processing.

In the remainder of the introduction, I first describe competing psycholinguistic models of sarcasm processing. This is followed by a brief summary of research that has been conducted on sarcasm processing in clinical and normal populations, paying special attention to studies which have used contextual and prosodic variables. Finally, I identify several issues which the current research has not addressed.

Psycholinguistic Models of Sarcasm

In order to understand why the RH has been implicated in the processing of sarcasm, it is essential to be familiar with the major psycholinguistic models describing how sarcasm is processed. Several decades ago, psycholinguistic theorists turned their attention to proposing and testing models of sarcasm and verbal irony (Grice, 1975, 1978; Sperber & Wilson, 1986; Williams, 1984; Gibbs, 1986a,b; Slugoski & Turnbull, 1988; Kreuz & Glucksberg, 1989). Most theorists have defined sarcasm as a form of verbal irony used in a negative (hurtful/critical) way (McDonald & Pearce, 1996); where verbal irony is considered an indirect speech act in which the meaning intended is the opposite or different from the literal meaning (Haverkate, 1990). The idea of “positive sarcasm” has been suggested, although it is unclear as to whether this can be truly considered sarcasm or simply “banter” (Slugoski & Turnbull, 1988). Regardless, it is in the interest of psycholinguists to determine how this intended meaning is communicated by the speaker and comprehended by the listener.

The “traditional” psycholinguistic model of sarcasm comprehension was proposed by Grice in 1975. He explained the conveyance of sarcasm in the broader context of the communication of conversational inference and proposed a model that can be applied to other indirect speech acts (McDonald & Pearce, 1996). The Gricean model proposes that the listener first analyzes the complete literal interpretation of the verbal statement, before then deriving the non-literal, sarcastic interpretation. His theory proposes a sequential three step model of processing in which (a) the literal meaning is comprehended; (b) some cue indicates that this is not sufficient (the literal meaning is contradicted by the context); (c) inferential rules are implemented in order to derive the intended meaning from the literal meaning and the context in which it occurred (McDonald & Pearce, 1996, p. 82). Therefore, the ironic or sarcastic statement conveys more than just meaning (the opposite of what was said) but also conveys the speaker’s attitude. Moving from the abstract to the concrete, consider the statement “It’s a beautiful day”. According to the Gricean model, in order to comprehend this statement as sarcastic, the listener first comprehends this statement as true (i.e. that the weather is sunny and warm). Next, they use contextual factors to determine whether or not this statement is true or intended to be true (e.g. they look outside, have prior knowledge of the current weather situation or notice that the speaker is soaked from rain). From this, the listener, noticing that the statement is obviously false (if the speaker is rain soaked), reinterprets the statement, considering alternative meanings and the context.

The Gricean model rests on two main assumptions: (1) the speakers will cooperate with each other in the act of communication and (2) they will follow certain principles (maxims) by saying only as much as is required, saying this as clearly as

possible and saying only what is true and relevant to the context. Critical to these assumptions is that both parties (speaker and listener) understand and recognize these maxims. Therefore, a deliberate violation of these conversational maxims will be noticed by the listener, and in turn, the listener will reconsider the statement, to make sense of why it was said in this manner. According to theory, in doing this, the listener must consider other contextual information to aid in interpretation. As a result, the final interpretation of the statement or conversation will be an inference drawn from both the utterance and the context in which it was said. Violating or “transgressing” these maxims allows the speaker to communicate indirectly in reverence to politeness or other societal or cultural factors.

In considering sarcasm, specifically, the conversational maxim of “Truth” is violated. Therefore, the listener, recognizes from the context that the literal meaning (“It’s a beautiful day”) contrasts with known facts (It is raining outside), but assumes that the speaker said this deliberately (communication; [maxim 1]). This requires the listener to reinterpret the statement to make it consistent with the context and thus, derives the *implied* meaning (usually the opposite of the stated). As it applies to the current study’s research question, the Gricean model supports the view that a RH advantage in processing sarcasm would be due to its involvement in higher level language processing and advantage in the activation of multiple meanings of ambiguous situations and ability to integrate information into the context of the current situation (Beeman, 1998) .

Like most preliminary theories, the Gricean model was criticized by a number of researchers (Gibbs, 1986a, b; Gibbs & O’Brien, 1991; Sperber & Wilson, 1986). One criticism of the model is that it fails to account for *all* instances of irony - such as ironic

statements that are both truthful and ironic (Gibbs and O'Brien, 1991). However, it has been argued that these instances may reflect other types of speech and do not directly counter the stage theory (see Haverkate, 1990, for full discussion). A more substantive criticism levied against the Gricean model is that it is simply inadequate in explaining how verbal irony is communicated and comprehended. Two arguments relating to this inadequacy will be discussed, due to their relevance in this paper.

Sperber and Wilson (1986) argued that the Gricean model did not account for the contribution of speaker attitude in the sarcastic utterance and furthermore, did not explain why the listener would choose one inferential meaning over a different one. Gibbs (1986a) also criticized the “stage” component of the model, and argued that it was unnecessary to assume that the literal meaning is first processed and then rejected. As a result of these criticisms, Sperber and Wilson (1986) proposed an alternative theory of irony comprehension as it relates to sarcasm. In their “Echoic” theory of sarcasm, they propose that, unlike the Gricean view, there is only one interpretation made by the listener. Comments are recognized as sarcastic because the listeners are reminded of a proposition that had been stated earlier or implicitly understood through shared knowledge (Kreuz & Glucksberg, 1989), which in turn, was proven wrong. In their view, the sarcastic statement is meant literally, but as an “echo” of a previously stated proposition or thought. In echoing this earlier proposition they are, most importantly, conveying their attitude toward it. In sum, the Echoic theory holds attitude as central to sarcasm, it proposes that the literal meaning is the only meaning conveyed and interpretation is derived by recognizing the relevance of the literal meaning (via the context).

In their review of the psycholinguistic models of sarcasm, McDonald and Pearce (1996) describe the major differences between the Gricean and Echoic theories. First, the Gricean model proposes that the literal meaning of the utterance is processed and then rejected for another meaning, whereas, the Echoic model argues that only the literal meaning is processed (where the interpretation is made using semantic content, speaker attitude and previously mentioned information). The other major difference between the two models is how the listener detects the sarcasm. In the Gricean model, the contradictory nature of the sarcastic remark results in this recognition, whereas, the attitude conveyed by the speaker, with a reference to previous state of events, alerts the listener to sarcasm in the Echoic model. McDonald and Pearce (1996) also review the results of empirical studies testing the Echoic against the Gricean model. Briefly, McDonald and Pearce (1996) concluded that “the only reliable attribute of sarcastic utterances that is necessary and sometimes sufficient is the juxtaposition of two or more incompatible elements (Williams, 1984; Kreuz & Glucksberg, 1989), and thus neither theory has received clear support” (McDonald & Pearce, 1996, p. 85) (see McDonald & Pearce, 1996 for further discussion of the models and empirical findings). In their own research on the validity of the psycholinguistic models in a clinical population, McDonald and Pearce (1996) did not find support for the Echoic model, but *did* find reasonable support for the Gricean model, although they conclude that they believe that the real mechanism may not be as straightforward as that explained by Grice’s model.

In a more recent response to the competing psycholinguistic models of irony, Giora and her colleagues (Giora, 1997, 1999; Giora & Fein, 1999a, 1999b, 1999c; Giora, Fein & Schwartz, 1998; as cited in Giora, Zaidel, Soroker, Batori & Kasher, 2000)

proposed that this processing depends on the salience of the particular word or expression. According to these researchers, it is “the degree of meaning salience rather than either context or literality (or non-literality) that affects processing primarily” (Giora, 2000, p. 64). For a word to be considered salient it must be coded in the mental lexicon (Giora et al., 2000). Giora uses the example of the “institutional” and “riverside” meanings of *bank*. The degree of salience of the meaning is determined by factors such as conventionality, frequency, familiarity and prototypicality, to name a few. In general, the degree of salience a word has for each person depends on individual differences and environmental factors. For example, the “riverside” meaning is more salient for individuals in rural settings, whereas the “institutional” meaning is more salient for urban residents. In the “graded salience hypothesis”, Giora proposes that the more salient meanings will be activated first, before less salient meanings. This model has implications for sarcasm as well. Giora (1997) argues that the sarcastic interpretations of statements are less salient and less conventional; thus, the salient meanings of these statements will be activated first. Therefore, in accordance with this aspect of her theory, it would be predicted that individuals interpret the sarcastic utterance literally first, before drawing on other less salient meanings for interpretation. Furthermore, this delayed comprehension is explained by the indirect negation view of irony which suggests that irony comprehension involves retention of the activated literal meaning while the listener analyzes the difference between the state of affairs suggested by the literal meaning and the ironic situation. Research using a brain damaged clinical population supported these hypotheses (Giora et al., 2000) and will be explained in greater detail later in this paper.

RH and Discourse Processing

Beeman & Chiarello (1998) have suggested that the RH is better at processing sarcasm because the RH is recruited to reinterpret meaning because of its greater flexibility, compared to the left hemisphere. As mentioned earlier, the RH has been found to have a special role in language comprehension in higher level language processing including making conversational inferences, understanding discourse and interpreting non-literal language (Beeman & Chiarello, 1998). Discourse comprehension in patients with right hemisphere lesions has been studied to examine the role of the RH in this process. It is assumed that deficits in discourse comprehension can be attributed to the RH damage, therefore indicating an RH role in the particular processes.

In an early study Wapner et al., (1981) found that right hemisphere damaged (RHD) patients made very literal reproductions in a story recall task and were impaired in their ability to distinguish between funny and unfunny on a humor task. These findings were interpreted as evidence for the right hemisphere's role in higher-level language processing, specifically in the construction and representation of discourse.

In a review of RH involvement in semantic coding and discourse, Beeman (1998) explains that the RH uses a “course” semantic coding when interpreting language, whereas, the LH uses “fine” semantic coding (Beeman, 1998). He argues that when a word is heard or read, the LH uses fine semantic coding to select a single relevant meaning and discarding the others. In contrast, the RH employs coarse semantic coding which weakly activates several meanings of the word, along with related features, that may be distantly related to the words, *given the context* (Beeman, 1998). Beeman (1998) suggests that this coarse semantic priming could explain the findings that the RH is crucial for understanding metaphors. In the same chapter, Beeman (1998) also cites

evidence implicating the role of the RH in comprehending indirect requests and non-literal meaning. An important study described in his review (see Beeman, 1998 for full discussion), was conducted by Weylman, Brownell, Roman & Gardner, (1989), who found that both RHD and LHD patients had difficulty choosing correct interpretations of indirect requests, but differed in the pattern of incorrect responding. Patients with LHD had more difficulty comprehending the elements of discourse, whereas patients with RHD had difficulty integrating the semantic components of discourse into the context as a whole. Kaplan et al., (1990) found similar results in that, compared to controls, RHD patients had difficulty using context to interpret whether conversational remarks were intended literally, humorously or sarcastically. These findings would support the proposition that in regards to the processing of sarcasm, the RH is superior because of its flexibility and coarse semantic coding. These processes allow the RH to be more specialized for the reinterpretation of literal meanings and also, for using context to determine the intention of conversational remarks.

RH and Affective Processing.

Although sarcasm can be generated without a prosodic element (e.g. sarcasm can be conveyed through written words), this is rarely the case. Prosody provides useful cues in sarcasm processing. Dichotic listening tasks have been used to examine cerebral asymmetries in the processing of prosodic or emotional content. Findings suggest a left ear advantage, which would implicate the RH, in the comprehension of emotional content (affective content, prosody, etc). The literature in this field is quite expansive, and for the purpose of the current study, this discussion will focus on studies which have investigated laterality effects for emotional stimuli, using dichotic listening tasks. Other dichotic

methods (e.g. visual field studies) have found a similar RH advantage for the comprehension of emotional or affective content (see Borod, Bloom & Haywood, 2005).

An early study that examined the laterality of auditory stimuli using words and emotions was conducted by Bryden and MacRae (1988). They developed a dichotic listening task, in which participants were presented stimuli to both ears simultaneously. The laterality effect was believed to emerge because the hemispheres were competing and could only process the stimuli input into that particular hemisphere. Therefore, hemispheric processing could be measured based on accuracy and reaction time.

Participants were presented short words spoken in different affective tones and were instructed to detect either the presence of a word or emotion. For word targets, they found an LH advantage and a RH advantage when participants were instructed to detect an emotion. Bryden and MacRae (1988) concluded that the RH was specialized for the processing of emotions, whereas verbal material was processed in the left hemisphere.

Grimshaw (1998) also examined hemispheric lateralization in a study using auditory stimuli that had been previously shown to elicit laterality effects (words and emotional tones). In the study, the words “mad”, “glad”, “sad” and “fad” were presented in angry, happy, sad or neutral tones. The goal of the test was to create an auditory “Stroop” task which could examine how the conflicting material would be processed in each hemisphere. Grimshaw (1998) used these pairings because they would create a conflict both at the processing level as well as between the two stimulus components. As hypothesized, Grimshaw (1998) found a LH advantage for words and an RH advantage for emotions. However, perhaps more interesting with regard the current study is that Grimshaw (1998) found that, overall, on incongruent trials (i.e. “sad” spoken in a happy

tone), words were identified more quickly and accurately than emotions. This suggests that words interfere with the identification of emotions (Grimshaw, 1998). This conclusion was supported further by the fact that there was not a significant interference of emotion on the identification of words.

Similar to Grimshaw's (1998) study, Techentin and Voyer (2007) used a dichotic listening task to determine whether the magnitude of the laterality effect could be increased if attention was controlled. According to Kinsbourne's (1970) attention model (as cited in Techentin & Voyer, 2007) the laterality effects found in Grimshaw's (1998) study could be the result of priming effects in the left hemisphere, because the participants were instructed to detect either the word or emotion, using verbal instructions. Because the target was presented verbally (i.e. the participants were instructed via computer screen to detect the word "mad" or the emotion tone "mad") this could have primed the LH, and could have contributed to the LH advantage for word targets. Therefore, they used randomized and blocked designs with pictures (faces indicating emotion) to instruct participants about the target. Their findings were similar to Grimshaw's (1998) in that they found an LH advantage for words and RH advantage for emotions. As for attentional set, the magnitude of the ear advantage was influenced by congruency of stimuli and block design (Techentin & Voyer, 2007). They concluded that when word and emotion were congruent, the emotion may facilitate the processing of the word and adds context to the word, rather than being processed as a separate component. This would keep the processing in the LH, which is supported by the LH advantage for congruent word targets. Techentin and Voyer (2007) suggested further that for incongruent word targets, the emotion may be more easily distinguished and cause

activation in the right hemisphere. They reasoned that this explanation accounted for the decrease in LH advantage when the word targets were incongruent.

As for emotion targets, Techentin and Voyer (2007) found a significant RH advantage for incongruent targets. They proposed that people expect the emotion and words to be congruent; and when this is not the case, the emotion becomes more important in processing. Given the RH specialization for processing emotion, this finding would make sense. The authors concluded that this has implications for the processing of sarcastic speech because an “incongruent emotional tone adds context to a statement and may change the linguistic meaning” (Techentin & Voyer, 2007, p. 653). This would support Nygaard, Queen and Burt’s (1998) claim that incongruent emotional tone requires additional processing which is likely to occur in the right hemisphere, thus producing the RH advantage.

These findings implicate a role for the RH in the processing of emotional content and information when the semantic and prosodic orientations are incongruent. Sarcasm is an ideal example of a situation in which prosodic and semantic factors may be incongruent and could explain the RH advantage in the processing of sarcasm.

Sarcasm and Brain Damage

After reviewing literature on RH involvement in processing discourse, non-literal language, and emotional information, in this section I focus on studies which have explicitly examined laterality effects in the processing of sarcasm. Perhaps the most practical application of the research on lateralization of sarcasm is the implication for brain damaged individuals. Identifying localized processes in language functioning as it pertains to each hemisphere is useful for determining functional limitations for individuals with hemispheric lesions. Most research on irony and sarcasm in brain

damaged patients has focused on comparing differences between right and left hemisphere lesions.

McDonald and Pearce (1996) explicitly tested the Echoic and Gricean models in a series of studies which examined the role of literal meaning in patients with frontal lobe (FL) damage. Ten patients with frontal lobe damage (varied in severity and locale) were tested on a task which required the interpretation of a written verbal exchange. For literally consistent exchanges, the FL-damaged patients did not differ from normal controls. However, when the verbal exchange was literally inconsistent (e.g. Mark: "That was a great football game", followed by, Wayne: "Sorry I made you come"), a portion of the patients could not reconcile the inconsistencies to detect sarcasm. This finding lends support to the Gricean model in that the ability to comprehend literal meaning alone was insufficient in detecting sarcasm (McDonald & Pearce, 1996). A central tenet of the Echoic model states that sarcasm is conveyed by speaker attitude. This was tested in a second study in which patients listened to the verbal exchanges read in a normal tone (consistent exchanges) or sarcastic (inconsistent exchanges) tone of voice. Despite the clear conveyance of attitude, the patients' performance did not increase compared to the first study. In a third, study they determined that the ability to detect sarcasm and the ability to detect attitude were independent functions. In sum, McDonald and Pearce (1996) found that for FL-damaged patients, the ability to process attitude was not associated with recognizing sarcasm. That the experimental group varied in the location and severity of dysfunction, indeed weakens the generalizability of these findings; however, McDonald and Pearce's (1996) results yield evidence in favor of the Gricean model over the Echoic model.

Research has been conducted examining the communication skills of patients with RH damage. In her review, McDonald (2000) reports many findings on impairments in communication functioning. She reports that patients with RH lesions have been found to have deficits in broad pragmatic skills, such as not providing enough information during discourse. RHD patients have also been found to have impairments in skills pertaining to indirect and inferential language comprehension. McDonald (2000) summarizes that RHD patients have difficulty detecting/processing sarcasm because of impairments in two areas of language processing. First, RHD patients are impaired in their ability to use prosodic cues when listening to a speaker's tone of voice. In addition, they have difficulty inferring the speaker's emotional state, which limits their ability to detect sarcasm. Second, they have difficulty inferring the speaker's intention which makes it difficult to view a situation from another's perspective, which also limits their ability to detect sarcasm (McDonald, 2000).

In a study by Shamay-Tsoory et al. (2005), the neuropsychological underpinnings of sarcasm comprehension were investigated using brain-damaged participants. Their findings give further support to RH involvement in comprehending sarcasm, specifically the right frontal lobes. They found patients with lesions in the right prefrontal cortex had more difficulty in understanding sarcasm compared to patients with left prefrontal cortex lesions, posterior (LH & RH) lesions, or bilateral lesions and healthy controls. Interestingly, they found no overall differences in the comprehension of sarcasm between RHD and LHD patients. However, when separated by region, there was a significant lateralization effect. Based on their findings, Shamay-Tsoory et al. (2005) proposed that sarcasm comprehension involves a neural network which uses both hemispheres at

different points. The RH, specifically the prefrontal cortex, is used for identifying the social and emotional context as well as the speaker intention. With damage to this region, the ability to understand sarcasm is greatly diminished because its impairment affects emotional recognition and processing.

Channon, Pellieff and Rule (2005), studied the comprehension of sarcasm in patients with closed head injuries (CHI). The localization of the damage to the brain in the participants was not known to the researchers. However, they believed that the patients mostly had damage to the right hemisphere and frontal lobes, based on the type of injuries sustained. Compared to healthy controls, the CHI patients exhibited an impaired ability to comprehend sarcasm. In addition, they found that the errors made by the CHI patients were mostly due to impairments in processing non-literal language. CHI was also associated with difficulty in mentalizing, which refers to the ability to understand another person's behavior in context with that person's mental state.

Giora et al. (2000) tested the lateralization of irony in brain-damaged individuals. They proposed that sarcastic irony would involve mostly a RH contribution, whereas understanding conventional metaphors would require LH involvement. They found that RHD patients exhibit deficits in comprehending sarcasm compared to LHD patients and normal controls. On the other hand, LHD patients showed deficits in the comprehension of conventional metaphors compared to RH brain-damaged patients and normal controls. Giora et al. (2000) explained their findings in the context of the graded salience hypothesis. Because the metaphors were conventional utterances, the necessary information was stored with other linguistic knowledge in the LH and could be retrieved directly. However, sarcasm involves interpretations that are not stored in the mental

lexicon; therefore they require linguistic reinterpretation, for which the RH has an advantage (Giora et al., 2000).

Tomkins and Mateer (1985) also examined sarcasm comprehension in brain damaged patients. In the study, RHD patients listened to pairs of vignettes that primed either a positive or negative mood. Both vignettes ended in an identical positive comment, which would be interpreted as sincere (congruent) in the positive vignettes and incongruent in the negative vignettes. The last comment was spoken in a tone that was either consistent with what they expected (sincere or sarcastic) or inconsistent. The patients were asked to make judgments regarding the appropriateness of the final comment in regards to both emotional tone and semantic content. In addition, they answered questions about the vignettes which were designed to examine participant's understanding of factual and inferential information. Tomkins and Mateer (1985) proposed that this completion of this task required three processes. First, participants must comprehend the verbal message and the associated attitude implied. Second, they must be able to extract intonational information and assign affective meaning to it. Finally, the listener must compare the verbal and prosodic interpretations to determine whether they are congruent or incongruent. Supporting with the authors' hypothesis, the participants had difficulty judging the appropriateness of the emotional tone when final comment was incongruent. Furthermore, the participants displayed deficits in integrating the incongruent information into their understanding of the vignette, as evidenced by their inability to make inferences from this information. Tomkins and Mateer (1985) suggested that RH impairments may have caused patients to be less able to process complex emotional information.

In a similar study, Kaplan et al. (1990) examined RHD patients using a vignette format. They were asked to answer questions asked about the speaker's intention and its effect on the listener. Similar to the Tompkins and Mateer (1985), RHD patients performed just as well as controls in drawing inferences about the speaker's intention and the emotional relationship between speaker and listener when the end comment was consistent with the rest of the story. However, when the end comment was inconsistent or counterfactual with the story, RHD patients were less likely to use information about the affective states of both speaker and listener in the interpretation of the vignette.

Sarcasm and normal population

The majority of irony (and sarcasm) research has focused on clinical populations, however a few have used a normal population. Capelli, Nakagawa and Madden (1990) were interested in how sarcasm comprehension differed between children and adults. Citing psycholinguistic models of sarcasm (Gibbs, 1986a, 1986b; Jorgensen, Miller & Sperber, 1984), Capelli et al., (1990) recognized that adults rely most heavily on two cues when detecting sarcasm: context and intonation. The researchers were interested in how children differed from adults in the degree to which cue was used. In their study, participants (adults, third graders and six graders) listened to stories and had to answer questions afterwards. The stories differed in context and the intonation of the last utterance, which created four different versions of each story. The No Cue version consisted of a neutral text (literal) and neutral tone; the Context Only version consisted of a discrepant text and neutral tone; Intonation Only had a neutral text and sarcastic intonation and finally, the Both Cues version consisted of a discrepant text and sarcastic tone. Capelli et al. (1990) found that children used intonation more frequently than

context when detecting sarcasm. In fact, children made the most errors in the Context-Only version of the story indicating that children may not have developed the abilities necessary to use contextual information to make inferences about the speaker's intended meaning (Capelli et al. 1990). As for the adults, they did not differ in the use of context and intonation; they were easily able to detect sarcasm with either cue. The design of Capelli et al. (1990) study is similar to the current study in its attempt to examine how both contextual and prosodic factors are used to detect or process sarcasm. It is important to note that both children and adults performed best with the Both Cues task. These results suggest that in some instances, the interaction between contextual and prosodic factors facilitate sarcasm processing.

Rockwell (2000) proposed that sarcasm could be detected from prosody alone. She argued that prosody characterized by lower pitch, louder intensity, and slower tempo could effectively produce sarcasm intonation detectable to participants. According to Rockwell (2000), most research on sarcasm has focused on *what* was said, rather than *how* it was said. She tested this theory by having experienced speakers record audio stimuli intended to convey sarcasm. The audio stimuli consisted of target statements read in the context of a story and spoken in either a sarcastic (spontaneous sarcasm condition) or non-sarcastic tone (non-sarcasm condition). In a third condition, context-independent phrases were read, which relied most heavily on prosody to convey sarcasm (posed sarcasm condition). To ensure that prosody was the critical factor in conveying sarcasm, the stimuli were acoustically digitized so that the verbal content was indiscernible, causing the participant to rely only on the prosodic features. Results indicated that sarcasm was able to be detected without verbal content. These findings support the

existence of a “sarcastic” tone of voice, characterized by lower pitch, louder intensity and slower tempo.

Voyer, Techentin and Bowes (2008) were particularly interested in the Rockwell (2000) finding that sarcasm could be conveyed and accurately detected from short context-independent phrases. They examined this finding in greater detail in a study examining hemispheric lateralization in the processing of sarcasm, using a dichotic target detection task. Participants listened for specific target stimuli and reported the ear of entry. Generally, in target detection, participants are supposed to indicate whenever they hear a target stimulus, regardless of the ear. However, Voyer et al. (2008) wanted to determine how emotional tone contributed to processing the sarcasm, which would require the same verbal content presented to each ear (hemisphere) but in a different tone. Voyer et al. (2008) created 12 short phrases (e.g. “You’re a big help”) that were recorded in both the sincere and sarcastic tones. The task for participants was to indicate the location (Left or Right ear) of the sincere or sarcastic version. The results of Voyer et al.’s (2008) study found LH advantage for sincere phrases and an RH advantage for sarcastic phrases. From their results, they concluded that sarcastic statements are best processed in the RH, whereas sincere statements are processed primarily by the LH (Voyer et al., 2008). Their findings were consistent with past research literature on laterality in the processing of sarcasm.

In summary, the review of the literature has repeatedly supported a RH specialization for the comprehension of sarcasm. However, the reason for this specialization is still unclear. The RH specialization for the comprehension of sarcasm can be explained in at least two ways. First, the RH advantage could be attributed to

greater flexibility, with the ability to activate broad semantic connections to words, multiple meanings of ambiguous words and abstract conversational inferences. The results of the studies described in the review by Beeman and Chiarello (1998) support this view, though none of the studies explicitly measured sarcasm. Studies on brain-damaged individuals that have tested the processing and comprehension of sarcasm have found evidence to support this theory as well (McDonald & Pearce, 1996; Tompkins & Mateer, 1985; Shamay-Tsoory, 2005; Kaplan, 1990; McDonald, 2000; Channon et al., 2004). The findings indicate that patients with RH brain damage have trouble understanding contextual factors related to conversation and have trouble reconciling inconsistencies in semantic content. For the most part, these difficulties persist even when the ability to detect and comprehend prosody is grossly intact. The theory that RH specialization for the processing of sarcasm is due to its “flexibility” and abstraction/reinterpretive abilities fits well under the Gricean (1975) psycholinguistic model of sarcasm. According to this model, reinterpretation of literal meaning and drawing inferences are key components in processing sarcasm. Given the RH specialization for these functions it would be logical that this also explains the RH specialization for the processing of sarcasm.

The second explanation for RH superiority in sarcasm processing is simply due to the RH specialization in processing emotional content. Studies which have implemented dichotic listening tasks have demonstrated a LE/RH advantage in processing words spoken in an incongruent manner (i.e. semantic and prosodic inconsistency) and for processing emotional targets in general. (Bryden & MacRae, 1988; Grimshaw, 1998; Techentin & Voyer, 2007). Rockwell (2000) demonstrated that sarcasm can even be

comprehended in the complete absence of semantic content. Finally, Voyer et al (2008) found an LE/RH for short phrases spoken in a sarcastic tone of voice, whereas when they were spoken in a sincere tone of voice there was an REA. These findings, in part, support the Echoic model (Sperber & Wilson, 1986) of sarcasm, which assigns speaker attitude and affect as central components of sarcasm comprehension.

It would be optimal to design a study in which the effects of context and prosody could be disentangled in order to determine which factor drove the processing of sarcasm, however, given the inherent affective nature of sarcasm this may not be possible.

However, it could be useful to investigate how and when these factors (prosodic and contextual) are involved in the processing of sarcasm. The most current literature has focused on the reliance on prosodic factors involved in the processing of sarcasm, and context (semantic reinterpretation) seems to be falling to the wayside. This begs the question, what is the role of context and how does it interact with prosody?

Current Study

The current study attempted to replicate Voyer et al.'s (2008) study, using the same audio stimuli and dichotic listening task. One limitation of the Voyer et al. (2008) study was that explicit discourse contextual factors were ignored. The authors proposed that context was included in the study in the sense that context was created by the prosodic element in combination with the short phrases. However, it was of interest to examine the discourse context in conjunction with the paralinguistic context. To do this, sincere (literal) and sarcastic (non-literal) vignettes were constructed with the end of each vignette concluding with the critical utterance (the audio stimuli used by Voyer et al., 2008). A dichotic listening task was employed to test for laterality effects. The vignettes

were presented binaurally until the last phrase (critical utterance), which was presented dichotically. The sincere version was presented to one ear, while the other ear was simultaneously presented with the sarcastic version. The participants indicated which ear heard the target phrase (sincere or sarcastic). The aim of this study was to determine how the interaction between prosodic and discourse context influence the processing of sarcasm.

Based on the research findings involving RH language functions, and specifically those related to RH involvement in sarcasm, several predictions were made. First, when context was absent, a RH advantage for sarcastic stimuli and a LH advantage for sincere stimuli were expected based on Voyer et al.'s (2008) findings. Second, when vignettes were heard prior to the prosodic phrases, the same pattern of results was expected when the context and prosody were consistent (e.g. literal context and sincere tone). Third, considering Capelli et al. (1990) findings, the consistency between discourse and prosodic context should facilitate processing so that performance would be better (greater accuracy) relative to when discourse context was absent. The picture becomes less clear when the discourse and prosodic context are inconsistent (e.g. literal discourse context and sarcastic task). Grimshaw's (1998) and Techentin and Voyer's (2007) findings of an RH advantage when semantic and prosodic content are incongruent suggests a RH advantage for the inconsistent conditions. Finally, it was considered likely that discourse and prosodic context inconsistency would inhibit processing and yield poorer performance in both hemispheres (compared to the No Vignette and context-prosody consistent conditions).

Method

Participants

Participants in the study were 54 undergraduate student volunteers from the Ball State University Psychological Science research pool. All participants completed the experiment and received experimental credit for participation. However, only data from righted-handed participants who reported normal hearing and English as their native language were used in the analyses. Of the 54 participants, 40 scored greater than +40 on the Edinburgh Handedness Inventory (1971) which was the cut-off implemented in order to be classified as “right handed”. Of the 40 classified as right handed, one participant’s data was excluded because of experimental error ($N = 39$)

Materials

The 12 critical phrases were the recordings used in the Voyer et al. (2008) study (Appendix A). There were two variations (sincere and sarcastic) for each of the 12 phrases. Each phrase was pronounced by the same female speaker in both a sarcastic and sincere tone of voice. These stimuli were tested by Voyer et al. (2008) to ensure that the intended intonation would be perceived by the listener (see Voyer et al. 2008 for details regarding selection and testing of the stimuli).

Two vignettes were created for each variation of the critical phrase (for a total of 24 scenarios). Each pair of vignettes was similar in nature; however, they differed in context they provided. In one case, the vignette contained information which was discrepant with the literal interpretation of the critical phrase in a way that should have led to a sarcastic interpretation of the phrase (sarcastic biasing). In the other case, the vignette contained information which was neutral with respect to interpretation and was consistent with the literal interpretation (literal biasing). For example, consider the

critical phrase “You’re a big help”. Two vignettes were created for this phrase; one which primed a literal interpretation of the critical phrase (consistent with the sincere intonation) and one which primed a non-literal interpretation of the critical phrase (consistent with the sarcastic intonation).

The audio stimuli were presented through headphones. A program written with E-Prime Version 1.0 (Schneider, Eschman, & Succolotto, 2002a, 2002b) controlled the presentation of the stimuli and record participants’ responses.

The Edinburg Handedness Inventory (Oldfield, 1971) was administered to each participant to assess handedness. For this questionnaire, participants were asked to rate the strength of hand preference for 10 tasks (e.g. striking a match, drawing, throwing, etc). These ratings were calculated to produce a ‘Laterality Quotient’ which could range from +100 (totally right-handed) to -100 (totally left-handed). For the sake of the Voyer et al., (2008) replication, only those who scored greater than + 40 on the Edinburg Handedness Inventory (Oldfield, 1971) which classified them as right handed would be included in the analysis.

Procedure

The experiment was divided into two main blocks: Vignette and No Vignette. In the Vignette block, participants listened to vignettes binaurally, until the last (prosodic) statement, which was presented dichotically. One ear heard the statement spoken in a sincere tone, while the other ear heard the comment in a sarcastic tone. In the No Vignette block, participants did not hear vignettes and only were asked to make judgments about the prosodic stimuli which were presented dichotically. Within each block all participants completed two tasks. In one task, participants were asked to

identify which ear heard the sarcastic version of the phrases; in the other task, participants were asked to identify which ear heard the sincere version of the phrases. The order in which the participants completed these two tasks was randomized within each block.

For each block, participants first completed six practice trials. To control for practice effects, the stimuli (vignettes and prosodic phrases) used in the practice trials were not the same stimuli used in the experimental trials, but were constructed in a similar nature (literal or non-literal context, with the last comment spoken in either a sarcastic or sincere tone).

On each trial, participants were asked to indicate which ear, right or left, heard the sincere comment (Sincere task) or the sarcastic comment (Sarcastic task). Participants indicated their responses by pressing the designated “Left” and “Right” buttons on the response box with their right hand. The recorded responses served as the accuracy measure.

Each participant completed a total of 192 experimental trials. In the Vignette block participants completed 96 trials [24 vignettes (12 literal + 12 non-literal) X 2 ears (left, right) x 2 tasks (ID sarcastic, ID sincere)]. In the No Vignette block participants completed 48 trials (12 phrases X 2 ears X 2 tasks = 48) repeated twice for a total of 96 trials. The vignettes were presented in a random order in each task and the order of the blocks and tasks were counterbalanced across participants. In this way, half of the participants completed the Vignette block first and the other half completed the No Vignette block first. Within each block, half of the participants were asked to identify the

sincere statements first, while the other half were asked to identify the sarcastic statements first.

Each participant sat at the computer and received verbal instructions. Instructions were also displayed on the computer screen for the participant to read (Appendix B). Participants were given instructions for each task (listen for sarcastic vs. sincere), prior to the beginning of the task. Participants were administered the Edinburgh Handedness Inventory (Oldfield, 1971) on paper between blocks. After the task, an explanation of the study was given and participants were thanked for their participation.

Results

Data analysis consisted of a 2 x 2 x 3 repeated measures factorial analysis of variance with Ear of presentation (left, right), Task (sincere, sarcastic), and discourse Context (consistent, inconsistent, context absent) as the independent variables, followed by tests on subsets of the data in accordance with the hypothesis. Accuracy (percentage of correct responses) served as the dependent variable in all ANOVA's. Previous research (Voyer et al., 2008; Techentin & Voyer, 2007) found that gender was not a significant variable and, thus, was not examined in this study. The probability of a Type I error was maintained at .05. For post-hoc comparisons a Bonferroni correction was used to adjust the alpha level. Five hypotheses were predicted at the outset of the experiment. The outcomes for these hypotheses will be discussed in order. Mean accuracy rates relevant to the following hypotheses can be found on Table 1.

Hypothesis 1 (See Table 1)

The first hypothesis predicted that the Voyer et al. (2008) findings would be replicated, in that without context, a left ear advantage (LEA)/RH would emerge for sarcastic statements and conversely, a right ear advantage (REA)/LH would be found for sincere statements.

To test this, a 2 X 2 (Ear X Task) repeated measures ANOVA was conducted for responses when the discourse context was absent. When context was absent (as in Voyer et al., 2008), the Ear X Task interaction was not significant, $F(1, 37) = .260$, $p = .613$. For sarcastic phrases the left ear/RH ($M = .789$, $SE = .026$) was not more accurate than the right ear/LH ($M = .782$, $SE = .023$). For sincere phrases, the right ear/LH ($M = .797$, $SE = .025$) was not more accurate than the left ear/RH ($M = .783$, $SE = .022$).

Hypothesis 2

The second hypothesis predicted that when discourse context and prosody were consistent, the same pattern of results predicted by the first hypothesis was expected. When the analysis was restricted to the Consistent condition, the Ear X Task interaction was not significant $F(1, 38) = .340$, $p = .563$. Planned comparisons were used to test hypothesized predictions. When discourse context and prosody were consistent and participants were instructed to locate sincere phrases (i.e. literal context and sincere task) there was no difference between right ear/LH performance ($M = .846$, $SE = .025$) and left ear/RH performance ($M = .848$, $SE = .025$), $F(1,38) = .006$, $p = .937$. Similarly, when instructed to locate sarcastic phrases (i.e. non-literal context and sarcastic task), there was no difference between RH performance ($M = .831$, $SE = .027$) and LH performance ($M = .804$, $SE = .029$), $F(1,38) = 1.169$, $p = .286$.

Hypothesis 3

The third hypothesis predicted that consistency between discourse context and prosody would facilitate processing so that accuracy would be increased relative to when discourse context is absent - regardless of hemisphere. The repeated measures analysis of variance revealed a significant main effect of Context, $F(1.433, 53.003) = 3.625, p = .048$. A Greenhouse-Geisser correction was used because there was evidence that the assumption of sphericity was violated, (*Mauchly's W* = .604, $p < .001$). Planned pairwise comparisons using *t*-tests, revealed that the third hypothesis was supported by the data. When discourse context and prosody were consistent ($M = .834, SE = .020$) accuracy was greater than when context was absent ($M = .788, SE = .018$), $p < .05$ (Bonferroni correction).

Hypothesis 4

The fourth hypothesis predicted that when discourse context and prosody were inconsistent (i.e. literal context and sarcastic task or non-literal context and sincere task) participants would be more accurate when the targets were presented to the left ear/RH compared to the right ear/LH. The hypothesis was not supported by the data. When the analysis was limited to the inconsistent condition, the main effect of Ear was not significant, $F(1, 37) = .464, p = .500$. However, a significant Ear X Task interaction emerged, $F(1, 37) = 6.601, p = .014$. Follow-up analyses revealed that contrary to the prediction, participants were more accurate when sincere statements were presented to the right ear/LH (sincere: $M = .833, SE = .033$) compared to the predicted left ear/RH (sincere: $M = .757, SE = .032$), $F(1, 38) = 7.482, p < .0001$. For sarcastic statements, the

data revealed a trend that supported the prediction made by the hypothesis, in that participants were slightly more accurate when the statements were presented to the left ear/RH ($M = .868$, $SE = .026$), compared to the right ear/LH ($M = .807$, $SE = .030$). However this finding had marginal significance, $F(1, 37) = 3.719$, $p = .059$.

Hypothesis 5

It was predicted in the fifth hypothesis that regardless of hemisphere, inconsistency between discourse context and prosody would inhibit processing and yield less accuracy when compared to when these factors were consistent trials and when no context was provided. Therefore, it was expected that accuracy on trials in the Inconsistent condition would have been significantly less accurate than both the Consistent and Context Absent conditions. The data were not consistent with the hypothesis. Pairwise comparisons were made using t -tests and indicated that Inconsistent ($M = .817$, $SE = .011$) vs. Consistent ($M = .834$, $SE = .022$) conditions were not significantly different, $p = .126$. Similarly, the Inconsistent vs. Context Absent ($M = .788$, $SE = .018$) conditions were not significantly different, $p = .181$.

Discussion

The purpose of the present study was to examine the contribution of the discourse context and prosody in the processing of sarcastic and sincere stimuli by the cerebral hemispheres. A RH advantage for processing, recognizing and identifying sarcastic material has been well documented in the literature for brain-damaged populations (described earlier). Specifically, studies involving participants with RH damage have shown deficits in the ability to recognize and perceive sarcasm. Additionally, Voyer et

al.'s (2008) study with a normal populations using dichotic listening tasks produced findings which suggest a RH advantage (compared to LH) in accurately identifying sarcastic stimuli. However, as mentioned earlier in the paper, the explanation for these findings has not been consistent. A review of the literature reveals two lines of reasoning for this effect. Some researchers attribute the laterality effect to the ability of the RH to more accurately process/recognize emotional/affective content; while other researchers believe that the advantage reflects the recruitment of the RH for “broad” semantic coding of discourse context, that is, the ability to reinterpret the literal meaning of phrase and arrive at the non-literal comprehension necessary for understanding sarcasm.

In light of this debate, the current study examined how accuracy differed when discourse context and prosody were consistent versus when these factors were inconsistent. I predicted that consistency between discourse context and prosody would lead to facilitation of sarcasm processing in general, and the pattern of hemispheric lateralization for sincere and sarcastic stimuli found in Voyer et al. (2008), would be more pronounced. In addition, I investigated how the pattern of results would change when discourse context prosody were inconsistent. It was predicted that inconsistency between discourse context and prosody would result in an overall RH advantage, regardless of whether the participants were instructed to identify sarcastic or sincere statements. A secondary aim of the current study was to reproduce the Voyer et al. (2008) study which found a RH advantage for processing sarcastic stimuli and an LH advantage for processing sincere stimuli. Theirs was the first study to use a normal population to explicitly examine cerebral lateralization in sarcasm processing using a

dichotic listening task. Given that these findings were the first of their nature, it was necessary to replicate this study to determine the reliability and validity of these findings.

Replication

The findings of the Voyer et al., (2008) study were not replicated in the current study. Voyer et al.'s (2008) findings for accuracy differed vastly from the findings in the current study (See Table 2 for a comparison of Voyer et al., (2008) and the current replication). The data trended in the predicted direction (although not significant) but the notable difference between the Voyer et al (2008) findings is the difference in overall accuracy between the two studies' samples. Compared to the Voyer study, the current study found much greater accuracy rates, regardless of hemisphere and prosodic target. The accuracy rates in the current study ranged from 78.2% to 79.7% ; whereas accuracy ranged from 66.3% to 76.2% in Voyer et al. (2008). It is possible that the higher overall accuracy rate created a ceiling that diminished the likelihood of any patterns of hemispheric asymmetry emerging.

The fact that Voyer et al. (2008) were not replicated was somewhat surprising given the lengths taken to ensure that the current study was constructed step-for-step as similarly as possible. The same 12 critical phrases (sincere and sarcastic versions) were used in the current study. In addition, the exact same computer software was used in this study as in the Voyer et al (2008) study (E-prime Version 1.0). Furthermore, the those authors even donated the E-prime program files for use in the current study and those files were modified only slightly (to add the Vignette conditions and modify instructions) to be used in the current study. When considering just the context absent conditions, the

same critical stimuli and method of presentation was used. With these important factors being equal, what then, could account for the drastic differences?

It is possible that order of presentation could have accounted for the differences in performance between the two samples. In Voyer et al., (2008) participants listened to the critical phrases and made judgments regarding which ear heard which version of the critical phrase; while in the current study, participants did the same, but for half of the trials heard vignettes prior to making judgments about the critical phrases. Therefore, it is possible that for participants who experienced the Vignette condition first, performance in the No Vignette condition could have been affected due to the fact that they were primed to hear binaural content first (even though they received instruction/explanation prior to the second condition) or they may have been used to relying on context before making judgments. Regardless of the reasons for affected performance, it is important to be able to rule this out. Therefore, a variable was added to the data which encoded participants as either experiencing the Vignette or No Vignette condition first. An analysis of the data which only included participants who had experienced the No Vignette condition first, did not reveal a significant Ear X Task interaction ($F(1, 17) = .535, p = .474$). Therefore, it is reasonable to conclude that order of presentation did not account for the disparity between the current study's findings and the Voyer et al. (2008) findings.

A minor difference between the two studies was the written instructions given to the participants. In the current study, participants were given "overall" instructions before each task which pertained to the entire experimental session, but were specific to which prosody was targeted in the particular block (e.g. indicate which ear heard the

“SINCERE” version) and amounted to a brief overview of the conditions and tasks they would be completing (See Appendix B). In the Voyer et al., (2008) study, participants were only given task specific instructions (e.g. indicate which ear hear the “SINCERE” version). It is possible that reading the brief overview of the experiment could have affected participant’s performance in the No Vignette condition, although the instructions written for the current study were based on the instructions used in the Voyer et al, (2008) study.

Apart from experimental error, the other notable difference between the two studies was the sample. The Voyer et al. (2008) study was conducted at the University of New Brunswick, located in Fredricton, in the Canadian province of New Brunswick. Cultural differences may have accounted for the difference in findings between this study and the current study, perhaps Canadian students (from the New Brunswick province), in general, process sarcasm (and sincerity) differently than students from an Midwestern American university, however, it would be almost impossible to disentangle these cultural differences, given the closeness in proximity of the two countries.

A methodological difference between the two studies was the way in which participants communicated their responses. In the current study, participants indicated which ear heard the target stimuli by pressing “left” or “right” on a response box which was positioned on the right side of the computer and participants used their right hand to press the buttons. However, in the Voyer et al., (2008) study participants indicated their responses by saying “left” or “right” into a microphone, at which point the experimenter would press the appropriate button on the response box to record the answers. The approach used in the current study has been commonly used in lateralization tasks in

previous research. Voyer et al. (2008) suggested that using the typical method could affect participant performance because of laterality effects associated with motor control and that it would be potentially necessary to counterbalance responses across hand (i.e. participants would have to use the right hand to respond for half of the trials and use their left hand for the other half of the trials). In summary, the authors believed that using the right hand only to indicate responses would prime the contra-lateral left hemisphere, so that it would be more activated than the right hemisphere, which could cause participants to have more attention directed to the left hemisphere. The authors raise an interesting point although it does not appear to have been empirically examined. It was decided that the typical (right hand response) method would be employed in the current study because it has been more commonly used in dichotic tasks in previous research. However, future research in this area could explicitly examine whether there is a difference in performance between these two methods, as it may help to explain why the Voyer et al., (2008) findings differed.

Both the second and third hypotheses were made based on the Capelli et al. (1990) finding that providing discourse context facilitated accuracy in identifying differences in prosody (sarcastic and genuine). It seemed logical that providing context would facilitate processing in both hemispheres. Given that Voyer et al.'s (2008) findings were not replicated in the current study it was not entirely surprising that the pattern of results was not found when context was introduced either. However, the finding that accuracy, overall, increased when consistent context preceded the prosodic stimuli fits nicely with Capelli et al.'s (1990) findings and supports the notion that

context does, in fact, have a significant role in the ability to process sarcastic and sincere stimuli.

Manipulation of discourse context

Apart from the lack of replication of the Voyer et al., (2008) study, the manipulation of the context variables and the subsequent significant Ear x Task x Consistent interaction yielded some interesting findings (again see Table 1 for Means). As mentioned earlier, previous research has not examined how accuracy and processing are affected by the inconsistency of context, therefore my predictions were made based on inference from indirectly related studies (i.e. Techentin & Voyer, 2007, Grimshaw, 1998). Therefore, some of the interactions of different levels of these variables yielded somewhat counterintuitive, if not surprising findings. Perhaps the most unexpected findings were found on trials where discourse context was inconsistent with the tone of the utterance (Inconsistent condition). First, contrary to prediction there was no evidence for overall RH superiority on Inconsistent trials. In fact, when participants were asked to identify sincere statements, the LH was superior. Furthermore, the Inconsistent trials produced the strongest trend toward the pattern of results found in Voyer et al. (2008). Second, there was no evidence that the inconsistency between discourse context and prosody inhibited processing, as overall performance on Inconsistent trials were not significantly different from Consistent and Context Absent trials.

Although previous research had not specifically examined how *inconsistent* context affects the processing and accuracy of identifying prosodic statements, I made the assumption that when the vignette primed an interpretation that differed from the target,

so that it would be more difficult for the participant to accurately identify the prosodic statement. However, the data showed that this was not the case as there was no statistical difference between Inconsistent and the other conditions. There could be a number of explanations for this finding (or lack of finding). One possible explanation is that although the vignettes did provide a context for the prosodic stimuli that facilitated processing (see Hypothesis 3), the vignettes and prosody may not have been different enough for consistent and inconsistent differentiation to be warranted. I thought the vignettes I constructed would easily be interpreted as priming either a literal or non-literal interpretation of the data, when considering the semantic content of the prosodic phrases. Even if the vignettes were effective in priming literal and non-literal interpretations, it is possible that providing *any* context helped to facilitate processing.

Limitations/Potential Problems

The Voyer et al. (2008) study was the first to attempt to examine hemispheric lateralization of sarcasm using a dichotic listening task and therefore, replication was the goal of the current study, so that the conclusions drawn by Voyer et al. (2008) could be strengthened. However, as briefly mentioned earlier, a potential limitation of the current study was the role that differences in culture between the two study samples may have played in the ability to accurately detect sarcasm. Although the degree to which Canadian and American psychology students differ – as it relates to the recognition of prosody (sarcasm and sincerity) - remains in question, this issue must be taken into consideration anytime results are compared across cultures. However, a closer look at the data show that this may not have had a huge impact on the differences between the two samples because they are not limited to sarcasm detection, but also hold for the detection

of sincere statements (see Table 2). The data shows, that for whatever reason, American psychology students were better at recognizing prosody overall and at this point, cultural differences cannot be ruled out as an explanation for this finding.

Two major limitations of the current study involved the vignettes that were constructed and implemented in attempt to manipulate the discourse context. The vignettes were to prime either a literal or non-literal interpretation of the context, when coupled with the sincere or sarcastic versions of the critical phrases. I thought that the semantic content in the vignettes would make the perception of the vignettes blatantly obvious as to whether they primed a literal or non-literal interpretation. For this reason, pilot testing was not carried out to ensure that the desired interpretations actually occurred. This was a limitation in the current study because it is unknown whether the vignettes had the intended effect on priming discourse context. Therefore, it is possible that the discourse context was not even manipulated. Similarly, another limitation of the current study was that a neutral vignette (i.e. that did not prime a particular interpretation) was not implemented to serve as a filler in the experimental design. The most surprising results of the study were that for the Inconsistent condition, the data exhibited the pattern found in Voyer et al. (2008) and that the inconsistency between discourse context and prosody did not inhibit processing. It is difficult to generate explanations for these findings without completely understanding the effect the vignettes had on participants' processing. I reasoned earlier that it is possible that providing *any* context could have aided participants in identifying the prosodic statements. Providing a neutral filler would have accounted for the extent to which just hearing a short story (that has not nothing to

do with the critical phrases) could have affected the ability to identify and process these statements.

Future Research

As mentioned above, one of the primary goals of the study was to more fully understand the role of discourse context and prosody and how the interaction between these cues affected sarcasm processing. Given the results and limitations of the study, the contribution of each cue remains somewhat unclear. However, the findings do reveal avenues for future research on this topic. First and foremost, more replication studies are needed to increase the external validity of the general conclusion of RH specialization in sarcasm processing. The extant literature appears to show stronger support for RH specialization in clinical populations (e.g. RH-damaged) than for normal populations. The current study and the Voyer et al. (2008) study are the only two known studies to compare LH and RH performance on sarcasm processing with a normal population and the discrepancies in the data between the two studies makes the conclusions drawn by Voyer et al. (2008) less certain.

Echoing Voyer et al., (2008), another factor for future research to address would be the impact that stress has on sarcasm. In both studies (Voyer et al. and the current study) stimulus intensity and duration (essentially tempo) were kept constant and the only measured difference between the recorded sarcastic and sincere statements was pitch. However, Meyers (1999) has suggested the stress is key to recognizing prosody. Voyer et al., (2008) concluded that it was likely that the stress placed on different parts of the statement differed between sincere and sarcastic statements and they believe it would provide a strong cue to discriminate between the statements. The authors conclude that

the tasks used in their study most likely did not allow distinction between stress and pitch because both were left uncontrolled. Given that the current study used the stimuli from the Voyer et al., (2008) study, the same concerns could be applied. It is possible that this factor could also interact with the other cues (discourse context and prosody) examined in this study. Therefore, it would be useful for future research to investigate how stress is used as a cue in distinguishing sarcasm from other (e.g. sincere) prosodic statements.

As mentioned earlier, the effect that culture has on the ability to perceive and process different forms of indirect language (specifically sarcasm) and prosody should be examined more closely. The difference in overall accuracy rates between the two studies suggest that if other factors are accounted for, culture differences may affect the ability to process sarcasm. Studies examining the frequency of sarcasm in the media, entertainment and general social interaction could be useful in determining just how different Canadian and American cultures when it comes to sarcasm and may shed light on the reasons for the discrepancies between Voyer et al. (2008) findings and those of the current study.

Finally, future research should examine the degree to which discourse context can be manipulated in order to prime literal and non-literal interpretations. One limitation of the current study was that it was unclear whether or not the vignettes primed literal or non-literal interpretation. It was also unclear if just providing *any* discourse context facilitated the processing and recognition of prosodic statements, as evidenced by finding that inconsistency between discourse context and prosody did not inhibit processing compared to when these factors were consistent.

In conclusion, the present study did not replicate the Voyer et al. (2008) findings, and thus, did not support the previous finding and current prediction that the RH would be better at processing sarcastic stimuli and the LH would be better at processing sincere material – when context was absent. These results were surprising considering the lengths taken to ensure exact replication of the Voyer et al., (2008) study. However, it is important to remember that the Voyer et al. (2008) study was the first attempt to examine sarcasm perception using dichotic listening and it is plausible that finding may not be as reliable as expected. Indeed Voyer et al. (2008) call for replication to strengthen their conclusions. When discourse context was included and manipulated it was found, as predicted, that consistency between discourse context and prosody facilitated overall processing, compared to when discourse context was absent. However, contrary to prediction, the laterality effect found in Voyer et al., (2008) again, was not found in Consistent trials. The finding that inconsistency between discourse context and prosody did *not* inhibit processing was unexpected and future research may be necessary to explain this finding but it could be speculated that providing any context helps in processing prosodic statements. Perhaps the most interesting finding in the present study was that the Voyer et al. (2008) pattern of results expected, but not found in the Context Absent and Consistent trials (LH for sincere and RH for sarcastic), was indeed present in the Inconsistent trials. At this point, it is not clear why the pattern emerged on these trials and did not emerge on the other trials.

References

- Ackerman, B.P. (1983). Form and function in children's understanding of ironic utterances. *Journal of Experimental Child Psychology*, 35, 487-508.
- Beeman, M.J. (1998). Course semantic coding and discourse comprehension. In M. Beeman & Chiarello, C. (Eds.) *Right Hemisphere Language Comprehension: Perspectives From Cognitive Neuroscience*. (pp. 255-284). Mahwah, NJ: Lawrence Erlbaum Associate Publishers.
- Beeman, M.J. & Chiarello, C. (1998). Complementary right- and left hemisphere language comprehension. *Current Directions in Psychological Science*, 7, 2-8.
- Beeman, M.J. & Chiarello, C. (1998). *Right Hemisphere Language Comprehension: Perspectives From Cognitive Neuroscience*. Mahwah, NJ: Lawrence Erlbaum Associate Publishers. 408 pp.
- Borod, J.C., Bloom, R.L. & Santschi-Haywood, C.S. (1998). Verbal Aspects of Emotional Communication. In M. Beeman & Chiarello, C. (Eds.) *Right Hemisphere Language Comprehension: Perspectives From Cognitive Neuroscience*. (pp. 285-308). Mahwah, NJ: Lawrence Erlbaum Associate Publishers.
- Bryden, M.P. & MacRae, L. (1988). Dichotic laterality effects obtained with emotional words. *Neuropsychiatry, Neuropsychology, and Behavioral Neurology*, 1, 171-176.
- Capelli, C.A., Nakagawa, N. & Madden, C.M. (1990). How children understand sarcasm: The role of context and intonation. *Child Development* (61), 1824-1841.
- Channon, S., PelliJeff, A., & Rule, A. (2005). Social cognition after head injury: Sarcasm and theory of mind. *Brain and Language*, 93, 123-134.
- Cicone, M., Wapner, W., Gardner, H. (1980). Sensitivity to emotional expressions and situations in organic patients. *Cortex*, 16, 145-158.
- Gazzaniga, M.S. & Hillyard, S.A. (1971). Language and speech capacity of the right hemisphere. *Neuropsychologia*, 9, 273-280.
- Gibbs, R. W., Jr. (1986a). On the psycholinguistics of sarcasm. *Journal of Experimental Psychology: General*, 115, 3-15.
- Gibbs, R. W., Jr. (1986b). What makes some indirect speech acts conventional? *Journal of Memory and Language*, 25, 181-196.
- Giora, R. (1997). Understanding figurative and literal language: The graded salience hypothesis. *Cognitive Linguistics*, 7, 183-206.
- Giora, R. & Fein, O. (1999a). Irony comprehension: The graded salience hypothesis. *Humor*, 12, 425-436.

- Giora, R. Zaidel, E., Soroker, N., Batori, G., Kasher, A. (2000). Differential effects of right- and left hemisphere damage on understanding sarcasm and metaphor. *Metaphor and Symbol, 15*, 63-83.
- Grice, H. P. (1975). Logic and conversation. In P. Cole & J. L. Morgan (Eds.), *Syntax and semantics, Volume 3: Speech acts* (pp. 41-58). New York: Academic Press.
- Grice, H. P. (1978). Further notes on logic and conversation. In P. Cole (Ed.), *Syntax and semantics, Volume 9: Pragmatics* (pp. 113-127). New York: Academic Press.
- Grimshaw, G.M. (1998). Integration and interference in the cerebral hemisphere: Relationships with hemispheric specialization. *Brain and Cognition, 36*, 108-127.
- Haverkate, H. (1990). A speech act analysis of irony. *Journal of Pragmatics, 14*, 77-109.
- Kimura, D. (1961). Cerebral dominance and the perception of verbal stimuli. *Canadian Journal of Psychology, 26*, 111-115.
- Kinsbourne, M. (1970). The cerebral basis of lateral asymmetries in attention. *Acta Psychologica, 33*, 193-201.
- Kreuz, R.J. & Glucksberg, S. (1989). How to be sarcastic: The echoic reminder theory of verbal irony. *Journal of Experimental Psychology: General, 118*, 374-386.
- Martin, L.L. & Shrira, I. (2009). Relative hemisphere activation as a converging operation in social psychology. Unpublished manuscript.
- Meyers, P. S. (1999). *Right hemisphere damage*. San Diego: Singular.
- McDonald, S. (1999). Exploring the process of inference generation in sarcasm: A review of normal and clinical studies. *Brain and Language, 68*, 486-506.
- McDonald, S. (2000). Exploring the cognitive basis of right hemisphere pragmatic language disorders. *Brain and Language, 75*, 82-107.
- McDonald, S., & Pearce, S. (1996). Clinical insights into pragmatic theory: Frontal lobe deficits and sarcasm. *Brain and Language, 53*, 81-104.
- Nygaard, L.C., Queen, J.S. & Burt, S.A. (1998). Effects of affective tone of voice on spoken word recognition. *Journal of the Acoustical Society of America, 103*, 2985
- Oldfield, R.C. (1971). The assessment and analysis of handedness: The Edinburgh Inventory. *Neuropsychologia, 9*, 97-113.
- Rockwell, P. (2000). Lower, slower, louder: Vocal cues of sarcasm. *Journal of Psycholinguistic Research, 29*, 483-493.
- Rodway, P., & Schepman, A. (2007). Valence specific laterality effects in prosody: Expectancy account and the effects of morphed prosody and stimulus lead. *Brain and Cognition, 63*, 31-41.

- Schneider, W., Eschman, A., & Zuccolotto, A. (2002a). *E-Prime User's Guide: Version 1.0*. Pittsburg: Psychology Software Tools, Inc.
- Schneider, W., Eschman, A., & Zuccolotto, A. (2002a). *E-Prime Reference Guide: Version 1.0*. Pittsburg: Psychology Software Tools, Inc.
- Shamay-Tsoory, S. G., Tomer, R., & Aharon-Peretz, J. A. (2005). The neuroanatomical basis of understanding sarcasm and its relationship to social cognition. *Neuropsychology*, 19, 288-300.
- Slugoski, B.R. & Turnbull, W. (1988). Cruel to be kind and kind to be cruel: Sarcasm, banter and social relationships. *Journal of Language and Psychology*, 7, 101-121.
- Sperber, D., & Wilson, D. (1986). *Relevance: Communication and cognition*. Cambridge, MA: Harvard University Press.
- Techentin, C., & Voyer, D. (2007). Congruency, attentional set, and laterality effects with emotional words. *Neuropsychology*, 21, 646-655.
- Tompkins, C.A. & Mateer, C.A. (1985). Right hemisphere appreciation of prosodic and linguistic indications of implicit attitude. *Brain and Language*, 24, 185-203.
- Uchiyama, H., Seki, A., Kageyama, H., Saito, D. N., Koeda, T., Ohno, K., et al. (2006). Neural substrates of sarcasm: A functional magnetic-resonance imaging study. *Brain Research*, 1124, 100-110.
- Voyer, D., Bowes, A., & Techentin, C. (2008). On the perception of sarcasm in dichotic listening. *Neuropsychology*, 22, 390-399.
- Wapner, W., Hamby, S., & Gardner, H. (1981). The role of the right hemisphere in the apprehension of complex linguistic materials. *Brain and Language*, 14, 15-33.
- Weylman, S.T., Brownell, H.H., Roman, M. & Gardner, H. (1989). Appreciation of indirect requests by left- and right- brain-damaged patients: The effect of verbal context and conventionality of wording. *Brain and Language*, 36, 580-591.
- Winner, E., Levy, J., Kaplan, J., Rosenblatt, E. (1988) Children's understanding of non-literal language. *Journal of Aesthetic Education. Special Issue: Art, mind, and education*, 22, 51-63.
- Winner, E. Brownell, H., Happé, F., Blum, A. & Pincus, D. (1998). Distinguishing lies from jokes: Theory of mind deficits and discourse interpretation in right hemisphere brain-damaged patients. *Brain and Language*, 62, 89-106.
- Williams, J. P. (1984). Does mention (or pretense) exhaust the concept of iron? *Journal of Experimental Psychology: General*, 113, 127-129.

Table 1

Mean Percentage of Correct Responses and SE (in parentheses) for Discourse Context Condition as a Function of Task and Ear of Presentation

	Identify Sincere		Identify Sarcastic		Estimated Marginal Means
	Left Ear (RH)	Right Ear (LH)	Left Ear (RH)	Right Ear (LH)	Context
Context Absent	78.3 (2.2)	79.7 (2.5)	78.9 (2.6)	78.2 (2.3)	78.8 (1.8)
Consistent	84.9 (2.6)	84.9 (2.5)	82.9 (2.8)	81.1 (2.8)	83.4 (2.0)
Inconsistent	75.7 (3.2)	83.6 (3.4)	86.8 (2.6)	80.7 (3.0)	81.7 (2.3)

Table 2. *Comparison of Mean Accuracy Rates and SD (in parentheses) for the Current Study and Voyer et al. (2008)*

	Identify Sincere		Identify Sarcastic	
	Left Ear	Right Ear	Left Ear	Right Ear
	(RH)	(LH)	(RH)	(LH)
Current	78.3 (13.7)	79.7 (15.6)	78.9 (16.2)	78.2 (14.4)
Voyer et al. (2008)	67.5 (15.3)	76.2 (14.3)	75.6 (13.3)	66.3 (11.9)

Appendix A

Prosodic Statements and Experimental Vignettes

1. Critical Statement: “What a great day.”

Non-Literal

Jake and Melissa woke up in the morning and packed food, swimming rafts and a volley ball into their car. They drove two hours until they reached the beach. When they arrived at the beach it began to rain, and didn’t let up the entire day. In the afternoon, Melissa looked up at the sky and said, “What a great day”.

Literal

Jake and Melissa woke up in the morning and packed food, swimming rafts and a volleyball into their car. They drove two hours until they reached the beach. When they arrived at the beach, the sun was shining without a cloud in the sky. Melissa looked up at the sky and said “What a great day”.

2. Critical Statement: “Isn’t she friendly?”

Non-Literal

Cindy and Angela were walking down the halls of their office. As they were walking, they passed their boss Jan. Angela smiled at her and called out “Good morning boss!” Jan glanced at her and kept walking. After she had passed, Cindy remarked, “Isn’t she friendly?”

Literal

Cindy and Angela were walking down the halls of their office. As they were walking, they passed their boss Jan. Angela smiled at her and called out “Good morning boss!” Jan glanced at her, smiled and patted Angela on the shoulder. After she had passed, Cindy said “Isn’t she friendly?”

3. Critical Statement: “You’re a big help”

It was her first night in New York City and Susie was frantically searching for her hotel. She pulled up to a group of people standing on the sidewalk and asked them for directions. They looked at her and just kept walking. As she was driving away she called out “You’re a big help”.

It was her first night in New York City and Susie was frantically searching for her hotel. She pulled up to group of people standing on the sidewalk and asked them for directions. They stopped and gave her very detailed instructions about how to get to her hotel. As she was driving away she called out, “You’re a big help”.

4. Critical Statement: “Wasn’t that fun”

Joel and Karen were at the amusement park and spotted the grand opening of the new roller coaster called “The Intimidator”. They waited in line for three hours and finally were up next. The roller coaster climbed to the top and then dropped, sending them speeding around the track. Afterwards, Karen remarked “Wasn’t that fun?”

Joel and Karen were at the amusement park for the grand opening of the new roller coaster called “The Intimidator”. They waited in line for three hours and finally they got in. The coaster climbed to the top and stalled. They sat there for 30 minutes and finally had to be escorted down the ladder by machine mechanics. Afterwards Karen remarked “Wasn’t that fun?”

5. Critical statement: “Isn’t this exciting?”

Eric and Sara were at the big football game. There were two minutes left in the game and the score was tied. Sara leaned over to Eric and said “Isn’t this exciting?”

Eric and Sara were at the big football game. There were two minutes left in the game and their team was losing by 30 points. Sara leaned over to Eric and said “Isn’t this exciting?”

6. Critical statement: “That worked well.”

Bruce and Kathy were moving from their apartment to a house across town. The last piece of furniture, a mattress, would not fit in their car, so Bruce had the idea to strap it to the top of the car. They arrived at their house with the mattress still intact. Kathy remarked, “That worked well”.

Bruce and Kathy were moving from their apartment to a house across town. The last piece of furniture, a mattress, would not fit in their car, so Bruce had the idea to strap it to the top of the car. After driving for two miles the mattress slid off the roof of their car and into the middle of the road. Kathy remarked, “That worked well”.

7. Critical statement: “Nice outfit”

Amber was hosting a formal dinner party at her house and was greeting guests at the door. When Britney arrived wearing an expensive evening gown, Amber remarked “Nice outfit”.

Amber was hosting a formal dinner party at her house and was greeting guests at the door. When Britney arrived wearing jeans and a sweatshirt, Amber remarked “Nice outfit”.

8. Critical Statement: “Tell me about it”

On Monday morning before class Jane and Susie were discussing the weekend. Jane and Susie had both attended a party that turned out to be pretty wild. When Jane told Susie that the party had been pretty wild, Susie replied “Tell me about it”.

On Monday morning before class, Jane and Susie were discussing the weekend. Jane had attended a party but Susie had been unable to go. Jane stated that the party had been crazy Susie replied “Tell me about it.”

9. Critical Statement: “Thanks a lot”

Lisa was racing to make it to the bank because she wanted to make a withdrawal before it closed for the weekend. She arrived just as the teller was closing for the night. Lisa asked if she could make one quick transaction. The teller obliged and helped her withdraw the money, Lisa replied, “Thanks a lot.”

Lisa was racing to make it to the bank because she wanted to make a withdrawal before it closed for the weekend. She arrived just as the teller was closing for the night. Lisa asked if she could make one quick transaction. The teller refused and asked her to the leave. Lisa replied, “Thanks a lot.”

10. Critical Statement: “Wasn’t that great?”

Drew and Amanda went to the opening performance of *The Phantom of the Opera* put on by the university. The performance went very smooth and the lead actress was very impressive. As they were leaving the venue, Amanda remarked “Wasn’t that great?”

Drew and Amanda went to the opening performance of *The Phantom of the Opera* put on by the university. The performance was very sloppy and the lead actress forgot half of her lines. As they were leaving the venue, Amanda remarked, “Wasn’t that great?”

Critical Statement, “Aren’t you smart?”

Marcus and Heidi were about to watch a movie but the DVD player was not working. After spending 15 minutes working on it, Marcus devised a clever solution using the wires from the video game system. Heidi remarked, “Aren’t you smart?”

Marcus and Heidi were about to watch a movie but the DVD player was not working properly. After spending 15 minutes working on it, Marcus realized that that it was not plugged in. Heidi remarked, “Aren’t you smart?”

Critical Statement, “Aren’t you special?”

Jeff and Maria were both competing for position as a research assistant for an esteemed professor. After meeting with the professor, Jeff called Maria and informed her that he had the position. This was the third time that Jeff had been chosen over Maria for an academic achievement. So when she heard the news, Maria replied, “Aren’t you special?”

Jeff and Maria were both competing for a position as a research assistant for an esteemed professor. After meeting with the professor, Jeff called Maria and informed Maria that he was going to withdraw his application because he knew that she was better suited for the position. Upon hearing this Maria replied, “Aren’t you special?”

Appendix B

E-Prime Instructions

1. General Experiment Instructions

We are interested in how people understand sarcasm. Sometimes people convey sarcasm by what they say; sometimes people convey sarcasm in by the way they say something. In this experiment you are going to hear a variety of short scenarios describing an interaction between two main characters. The majority of the scenario will be presented to both ears, but the last phrase uttered by the characters in the scenario will be presented to each ear separately. For each scenario, one ear will hear a sarcastic comment, while at the same time, the other ear will hear a sincere comment. You will be asked to make decisions as to which ear (right or left) heard which type of comment.

You will indicate your response by pressing the button labeled “right” or “left” on the response box located on the right side of the computer. You will be asked to complete three tasks in this session. For one task you will listen to the stories and be asked to indicate which ear heard the sarcastic comment. For another task you will listen to the stories and be asked to indicate which ear heard the sincere comment. In between these two tasks you will answer questions about your hand preference for a variety of activities. Prior to each of the listening tasks you will be given six practice trials.

Please click the mouse when you are ready to begin

2. Sarcastic block instructionsPractice Instructions

You will now begin the practice trials. Please press the "Left" or "Right" button to indicate in which ear you heard the sarcastic comment.

Please click the mouse to begin the practice trials.

Experimental Instructions

You will now begin the experimental trials. Again, please say "Left" or "Right" to indicate in which ear you heard the sarcastic comment.

Please click the mouse to begin the experimental trials.

3. Sincere block instructionsPractice Instructions

You will now begin the practice trials. Please press the "Left" or "Right" button to indicate in which ear you heard the sincere comment.

Please click the mouse to begin the practice trials.

Experimental Instructions

You will now begin the experimental trials. Again, please say "Left" or "Right" to indicate in which ear you heard the sincere comment.

Please click the mouse to begin the experimental trials.

